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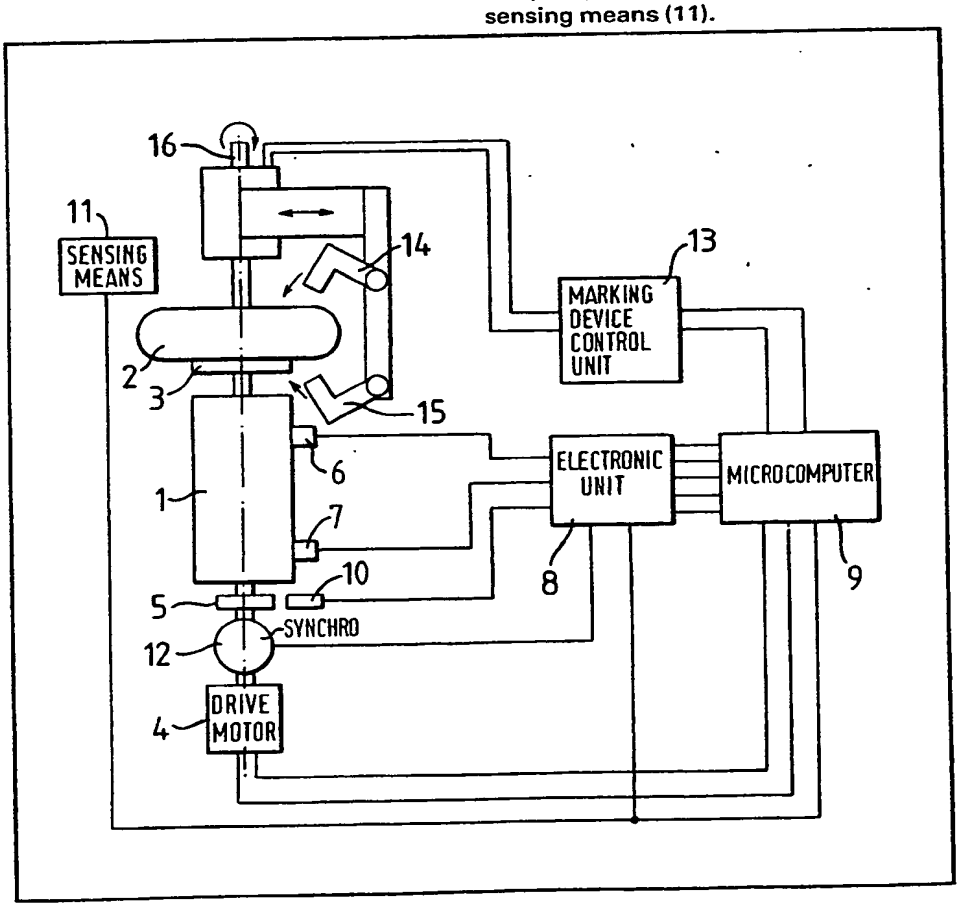
(54) Methods of and apparatus for indentifying points of unbalance on rotary bodies

(57) Points of unbalance on rotory bodies are identified by providing at least one marking at a position depending on the size and phase location of the imbalance as determined by a measuring means. The radius of the marking is controlled in dependence on the dimensions of the body.

Apparatus for so identifying points of unbalance on a rotary body (2) clamped on a balancing machine (1) includes marking devices (14 and 15) which mark the rotary body (2) at angular locations in accordance with the magnitudes and phase locations of unbalance detected by transducers (6, 7) and an electronic measuring unit (8). The marking devices (14 and 15) are controlled so that they mark the body (2) at locations in accordance with dimensions of the body (2) previously determined by a sensing means (11).



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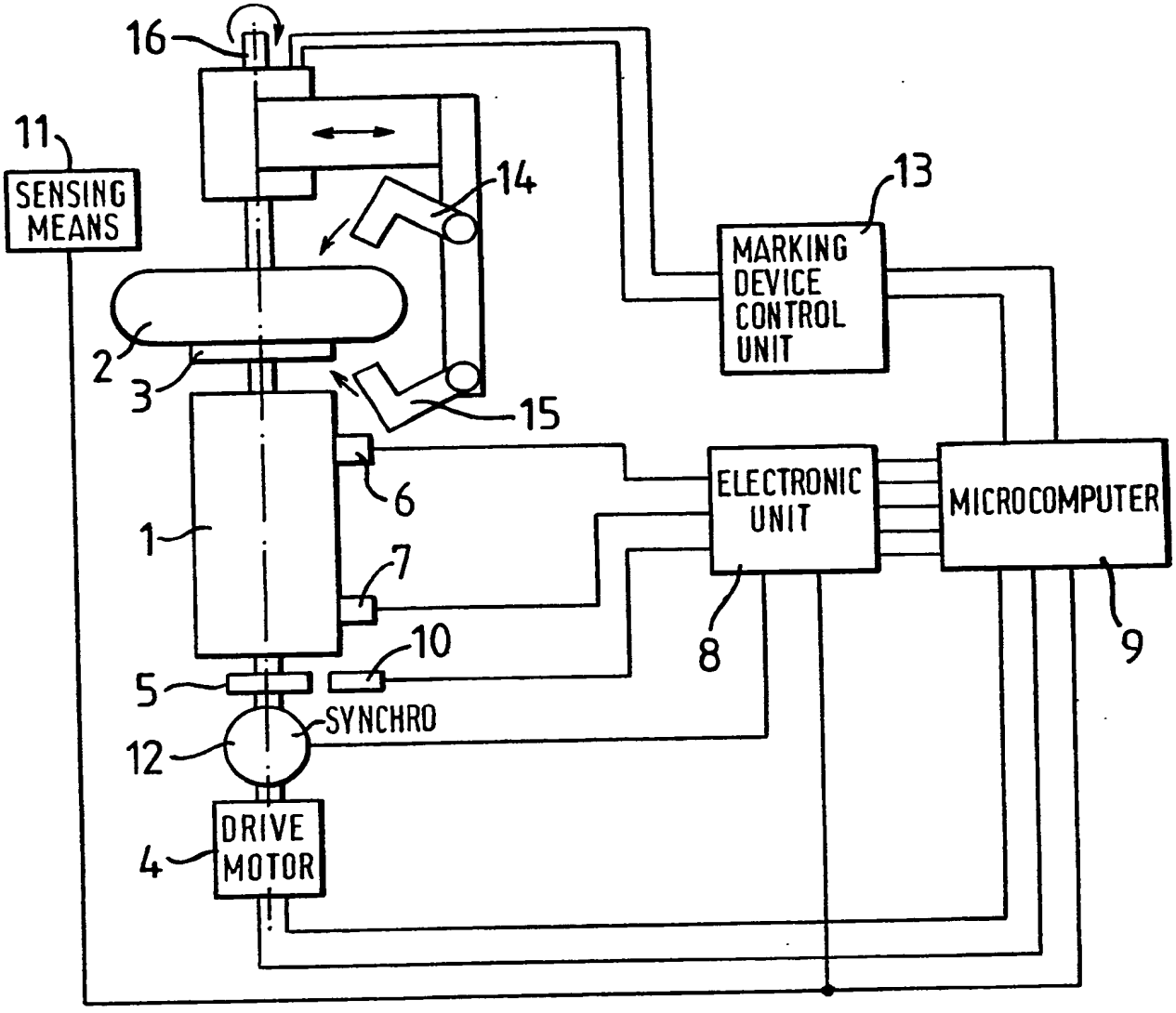
16
11
SENSING MEANS
14
13
MARKING DEVICE CONTROL UNIT
2
3
15
6
1
7
ELECTRONIC UNIT
MICROCOMPUTER
10
8
9
5
SYNCHRO
12
DRIVE MOTOR
4

SPECIFICATION

Methods of and apparatus for identifying points of unbalance on rotary bodies

The present invention relates to methods of and apparatus for identifying points of unbalance on rotary bodies.

For balancing motor vehicle wheels in two planes, it is known firstly to determine the unbalance of the wheel in a measuring station and then to compensate for the unbalance by means of balance weights applied in two subsequent balancing stations. For this purpose, the wheel is first automaticaly turned into a balancing phase (correction) location in the first plane. After a balance weight has been fitted, the wheel is transported by means of a gripper device to the next balancing station, and there turned through 180°. The wheel is then automatically turned into the balancing phase (correction) location in the second plane, and the balancing operation is performed.

Balancing machines of this kind are very expensive and also require a large installation area, which is often not avilable in the general production or conveyor line in a motor vehicle factory.

Other balancing machines are also known (Hoffmann Report No. 37 published by the present applicants), in which the unbalance is determined in two planes in a measuring stand, and the angular locations of the unbalance are marked on the tyre in both planes by means of marking devices. In these machines, the balancing operation is carried out in a subsequent balancing station. In that operation, the wheel is disposed on rollers and the operator turns the wheel to the required angular location or locations by hand. The balance weights corresponding to the magnitude of unbalance detected are indicated on a weight box so that the operator can take out the weights and fit them manually at the identified angular locations.

The operation of these machines requires skilled technical personnel because the balance weights must be fitted in two planes and must be fitted with care in order to avoid phase errors. Furthermore, subsequent checking is extremely difficult as the information relating to the magnitude and phase location of the unbalance is neither stored nor recorded.

German Utility Model No. 1 798 476 discloses an apparatus for identifying motor vehicle tyres, wherein the tyre is marked by a coloured strip, in dependence on the angular location of the unbalance and the magnitude of the unbalance, which magnitude is graduated into three gradations. The markings are applied directly to the side walls of the tyre and can therefore be easily rubbed off during subsequent movement thereof, especially as the markings can be disposed at different positions on the tyre, irrespective of the size of the tyre. In addition, the gradations we intended only for classification purposes and are much too inaccurate for subsequent balancing, so that this method does not meet present-day requirements.

According to the invention there is provided a method of identifying points of unbalance on rotary bodies, wherein a rotary body is provided with at least one marking at an angular location depending on the magnitude and phase location of unbalance determined by an unbalance measuring means, and wherein the dimensions of the body are determined and the marking operation is carried out on the body at a predetermined radius which is radially controlled in dependence on the determined dimensions, the marking corresponding to the magnitude and the phase location of the unbalance determined.

According to the invention there is also provided apparatus for identifying points of unbalance on rotary bodies, the apparatus comprising a marking device operative to mark the rotary body at a given angular location or locations in accordance with the magnitude and phase location of unbalance determined by an unbalance measuring means, the marking device being controlled in a radial direction of the rotary body during the marking operation by a sensing means operative to determine dimensions of the body in such a way that the marking on the body indicates the magnitude and the phase location of the unbalance determined.

An embodiment of the present invention described hereinbelow provides a method of and an apparatus for identifying points of unbalance which ensure reliable identification and marking on a rotary body (e.g. a motor vehicle wheel) of the magnitude and phase location of the unbalance, which also makes it possible to carry out a subsequent check.

Although it is known from the above-mentioned "Hofmann Report No. 37" for the type of wheel to be determined in respect of rim diameter, rim width and rim offset, the operation of determining this characteristic data is carried out for the purpose of setting an electronic measuring unit of the unbalance measuring means to the appropriate type of wheel. Embodiments of the present invention can make use of such characteristic data determining the type of wheel for the purpose of radially controlling the marking device with respect to the motor vehicle wheel to be identified.

Embodiments of the invention also makes it possible for the unbalance phase location and magnitude of unbalance to be identified in steps or continuously and in accordance with the size of the rotary body in such a way that the weight balancing operation can subsequently be carried out as far as possible within an overall production or conveyor line in a factory in a manner which also complies with ergonomic requirements.

The marking - in the case of a motor vehicle wheel - may be made on the rim of the wheel advantageously in the region of the rim flange of the motor vehicle wheel, preferably by means of a spray device or a laser, in such a way that it is possible subsequently to check whether the balance weight fitted and its position actually correspond to the determined data.

Measurements of the magnitudes of unbalance in steps or gradations enables the marking to be adapted, for example, to 5g or 10g gradations of commercial balance weights. However, it is also

possible to provide for continuous measurement of magnitudes of unbalance so that for example the unbalance correction weight required can be manually or automatically taken off a strip (e.g. from a coil) and subsequently applied at the marked location.

The measured and marked motor vehicle wheel can then be taken off and moved on to a subsequent station without the danger of the unbalance data being lost. The actual balancing operation, i.e. the fitting of balance weights, can be carried out within the conveyor line at a suitable position and in an ergonomically advantageous manner, as desired by the operator. By virture of the data relating to the magnitude and phase location of the unbalance being applied at a predetermined radius of the rotary body, checking of the balancing operation is also possible subsequently at any time.

The invention will now be further described, by way of illustrative and non-limiting example, with reference to the accompanying drawing, the sole figure of which diagrammatically represents an apparatus embodying the invention.

A rotary body 2, which is a motor vehicle wheel in the illustrated embodiment, is clamped by known means on a clamping means 3 of a balancing machine 1 (not shown in detail). The balancing machine is driven by a drive motor 4 which can be directly coupled to a balancing spindle of the balancing machine 1 by way of a drive shaft. The drive can also be produced by way of a flat belt 5 arranged between the drive motor 4 and the balancing spindle. The vibrations produced by the unbalance are detected by pick-up means or transducers 6 and 7 which can operate on a displacement measuring basis or a force-measuring basis. Output signals of the pick-ups 6 and 7 are applied to an electronic measuring unit 8. Sensing means 10 produces a reference signal which is in phase with the balancing spindle of the balancing machine 1. For this purpose, the sensing means 10 may for example scan a projection or cam on the machine spindle. However, it is also possible to use phase generators or comparable equipment, which are coupled in a fixed phase condition. The electronic measuring unit 8 subsequently determines, preferably after phase-controlled rectification, the magnitude and location of the unbalance in respect of the selected corresponding balancing planes.

The unbalance data is transmitted to a microcomputer 9 and may also be transmitted to a display unit (not shown).

The microcomputer 9 and the electronic measuring unit 8 are also fed with measurement data from a sensing means 11 which can be constructed in similar manner to the wheel type identifying unit (orientation stand) disclosed in the above-mentioned "Hofmann Report No. 37", in order to take account of different rotary bodies 2. The sensing means 11 thus determines the dimensions of the rotary body to be balanced, in the measuring station or in a station disposed upstream thereof, for example by means of sensors.

For the purposes of position checking, the electronic measuring unit 8 is also connected to a synchro or other rotary signalling means 12.

Positional voltages for controlling the rotary movement of the drive motor 4 to turn the rotary body 2 into the angular locations of the unbalance, and a subsequent indexing voltage for turning the drive motor into a so-called zero or initial position, are applied to the drive motor 4 by the microcomputer 9.

The microcomputer 9 further controls a marking device control unit 13, in accordance with the magnitude and phase location of the unbalance detected, and the size of the rotary body 2. The marking device control unit 13 may be used serially for two marking devices 14 and 15. However, it is also possible to provide a respective control unit 13 and a corresponding actuating means for each of the marking devices 14 and 15.

The marking devices 14 and 15 may be designed to be movable radially with respect to the rotary body 2 so that they can be set to predetermined radii of the rotary body 2. In addition, the marking devices 14 and 15 can be swivelled about the axis 16 of rotation of the body 2. Instead of rotating the marking devices 14 and 15 about the axis 16, the rotary body 2 can be rotated in the marking operation to a position below the stationary marking devices 14 and 15.

The marking devices 14 and 15 can also be arranged on the balancing machine 1 in such a way as to be completely movable about an axis which is substantially perpendicular to the axis of rotation of the rotary body 2, in order to enable the machine to be more easily loaded and unloaded. The marking devices 14 and 15 may be spray devices, a laser or comparable devices which apply a marking, advantageously in the case of motor vehicle wheels in the region of the rim flange of the wheel.

The marking may be for example in the form of a line, the length of which corresponds to the magnitude of the unbalance undetected, or in the form of a number, with a striking point of the marking indicating the detected angular location of the unbalance. Identification of the size of the balance weight to be fitted on the rim may be in stages or steps or continuous (directly proportional) depending on the form in which the balance weights are available.

In a preferred embodiment, only the beginning and end points of the balance weights to be applied are identified, while it is also possible to use a double marking device, the angle of spread of which is automatically adjusted by the magnitude of the unbalance detected.

It will be readily seen that an important feature of the described method and apparatus lies in identifying the magnitude of the unbalance on the rotary body, whereby it is possible to perform the balancing operation at any point on a general production or conveyor line. It is also possible to check the balancing operation at any time.

It will be appreciated that the invention is aplicable with advantage not only specifically in the case of motor vehicle wheels but quite generally on any rotary bodies, for example when balancing grinding wheels.

CLAIMS

1. A method of identifying points of unbalance on rotary bodies, wherein a rotary body is provided with at least one marking at an angular location depending on the magnitude and phase location of unbalance determined by an unbalance measuring means, and wherein the dimensions of the body are determined and the marking operation is carried out on the body at a predetermined radius which is radially controlled in dependence on the determined dimensions, the marking corresponding to the magnitude and the phase location of the unbalance determined.

2. A method according to claim 1, wherein the rotary body is a motor vehicle wheel.

3. A method according to claim 2, wherein the or each marking is made in the rim flange region of the wheel.

4. A method according to claim 1, claim 2 or claim 3, wherein the or each marking is applied by spraying.

5. A method according to any one of the preceding claims, wherein the lengths of the markings correspond to the size of balance weight to be fitted.

6. A method according to any one of the preceding claims, wherein the beginning and end points of the or each marking correspond to the size of balance weight to be fitted.

7. A method according to any one of claims 1 to 6, wherein the number of markings applied corresponds to the balance weight, the balance weight being graduated in stages.

8. A method according to any one of claims 1 to 6, wherein the or each marking represents the absolute value of the magnitude of unbalance and the unbalance phase location is indicated by the striking position of the marking.

9. A msethod of identifying points of unbalance on rotary bodies, the method being substantially as herein described with reference to the accompanying drawing.

10. Apparatus for identifying points of unbalance on rotary bodies, the apparatus comprising a marking device operative to mark the rotary body at a given angular location or locations in accordance with the magnitude and phase location of unbalance determined by an unbalance measuring means, the marking device being controlled in a radial direction of the rotary body during the marking operation by a sensing means operative to determine dimensions of the body in such a way that the marking on the body indicates the magnitude and the phase location of the unbalance determined.

11. Apparatus according to claim 10, for use with a rotary body in the form of a motor vehicle wheel, wherein the sensing means is a wheel type recognition device used for setting the unbalance measuring means to the respective type of wheel.

12. Apparatus according to claim 10 or claim 11, for use with a rotary body in the form of a motor vehicle wheel, wherein the marking device is operative to apply the marking in the rim flange region of the wheel.

13. Apparatus according to any one of claims 9 to 12, wherein the marking device is in the form of a spray device.

14. Apparatus according to any one of claims 9 to 12, wherein the marking device is in the form of a laser.

15. Apparatus according to any one of claims 9 to 14, wherein the marking device is operative such that the length of the marking corresponds to the magnitude of balance weight to be fitted.

16. Apparatus according to any one of claims 9 to 14, wherein the marking device is operative such that the beginning and end points of a marking correspond to the magnitude of balance weight to be fitted.

17. Apparatus according to any one of claims 9 to 16, wherein the marking device is operative such that the number of markings corresponds to the magnitude of the balance weight, the balance weight being graduated in stages.

18. Apparatus according to any one of claims 9 to 17, wherein the marking device is operative such that the marking represents the absolute value of the magnitude of unbalance and the striking position represents the unbalance phase position.

19. Apparatus according to any one of claims 9 to 18, wherein a respective marking device is provided for each of a plurality of balancing planes of the body.

20. Apparatus according to any one of claims 9 to 19, wherein the marking device may be swivelled about the axis of rotation of the body.

21. Apparatus according to any one of claims 9 to 20, wherein a double marking device is provided for each of a plurality of balancing planes, the angle of spread of the marking device being so controlled that it corresponds to the magnitude of balance weight to be fitted.

22. Apparatus for identifying points of unbalance on rotary bodies, the apparatus being substantially as herein described with reference to the accompanying drawing.

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